# HDR

WHAT IS THIS "MODEL" YOU SPEAK OF?

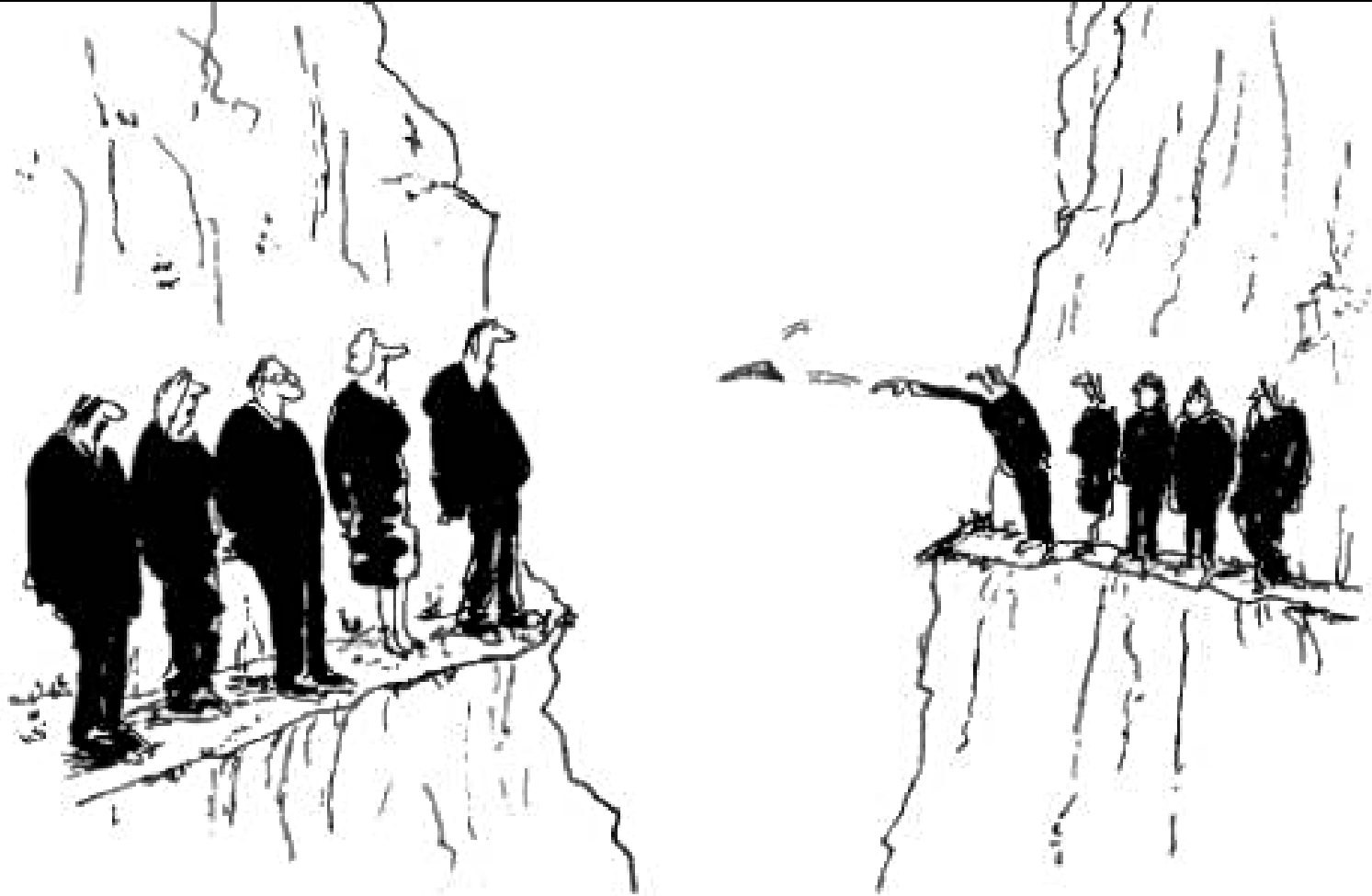**Bridging the Communication Gap**

HDR

What am I talking about?

- Bridging the communications gap
  - Speaking technically to a non-technical audience
  - Avoid causing the "glazed gaze"
- Provide some background to what that engineer is saying
  - Deciphering or translating the technical language
  - What is a model?
- Latest improvements in hydraulic modeling
  - New features and capabilities

Velocity Magnitude (ft/s): 0 2 4 6 8 10
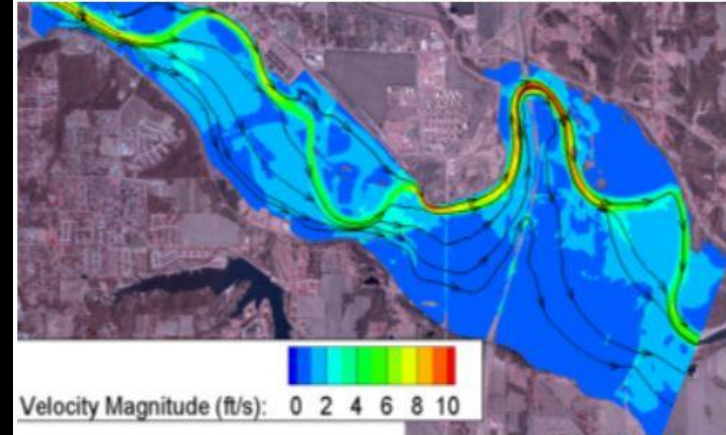
Bridging the Gap

Couldn't we communicate better if we built a bridge?

"Engineering Language"

- "Due to the numerous flow bifurcations, we utilized a finite volume model to simulate the complex hydraulic system using the full momentum version of the Saint-Venant equations."

- What they meant to say; "We developed a model of the project area to represent the flood."

Simplify the Message

- Keep your audience in mind
  - Technical and non-technical
    - Mother rule or K.I.S.S.
- Define terms and don't interchange them
  - Use solely that <u>one</u> term
    - 1% annual-chance, 100-yr flood, Q100, base flood
      - » Not once every 100 years
  - Floodplain versus floodway
- Use memorable events
  - 2011 was 1,000 cfs, the represented event is 2,000 cfs
  - Helps with the "I've lived here 10 years and it's never flooded."
- Use images, figures, text on maps

Simplify the Message

o Avoid acronyms

- BFEs and WSELs → Elevation of the flood

o Avoid modeling/technical talk

- Headloss, Manning's roughness, conveyance, interpolation

o Avoid referencing FEMA and local guidelines

- Appendix X.1.3 of such and such states that…
- This is standard practice
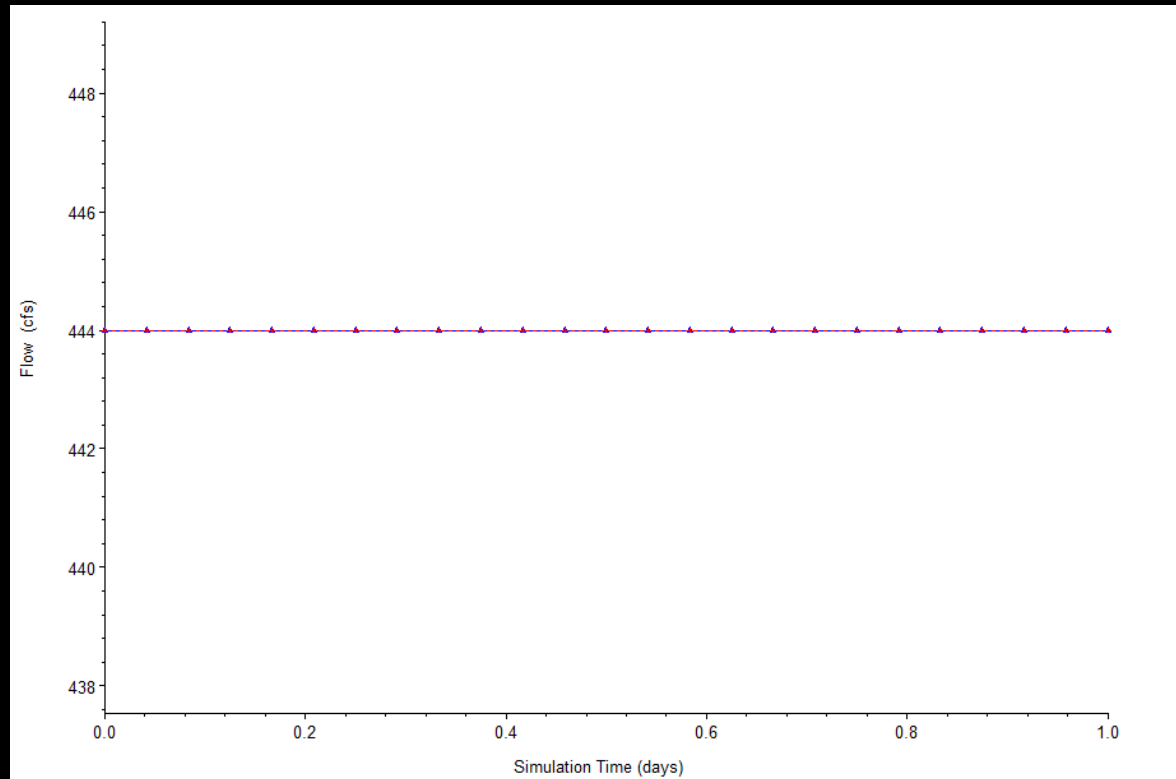
o **_Understand the audience's point of view_**
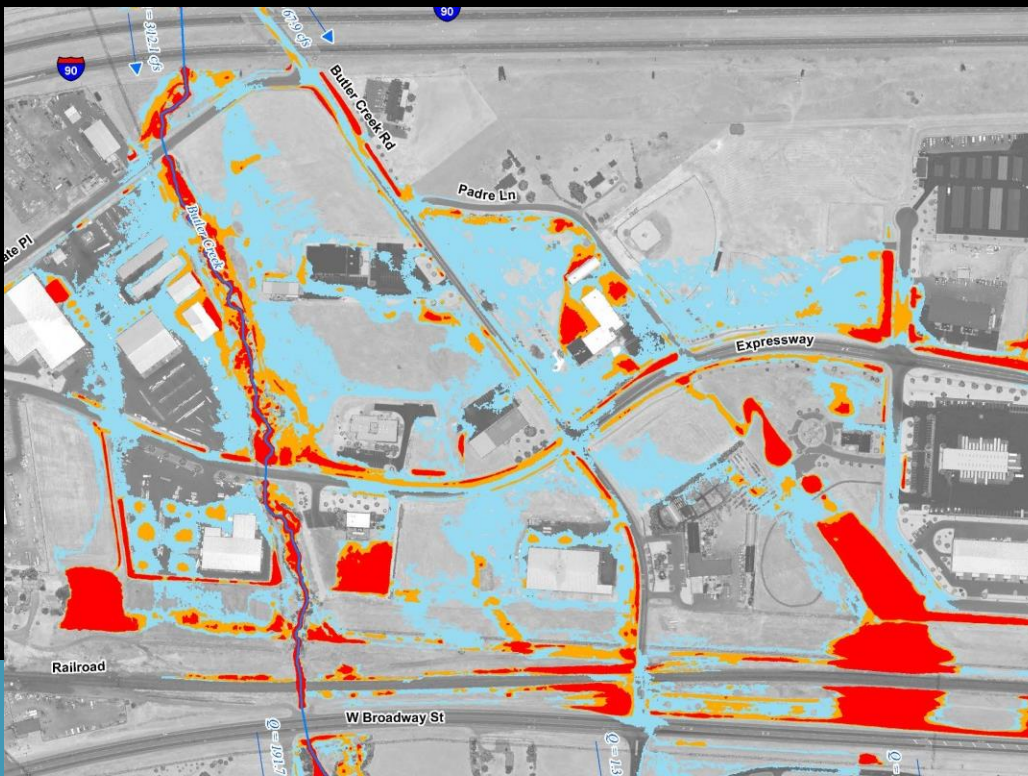
Technical Talk

- Discharge
- Steady state

Non-technical talk

- Flow (i.e. how much water)
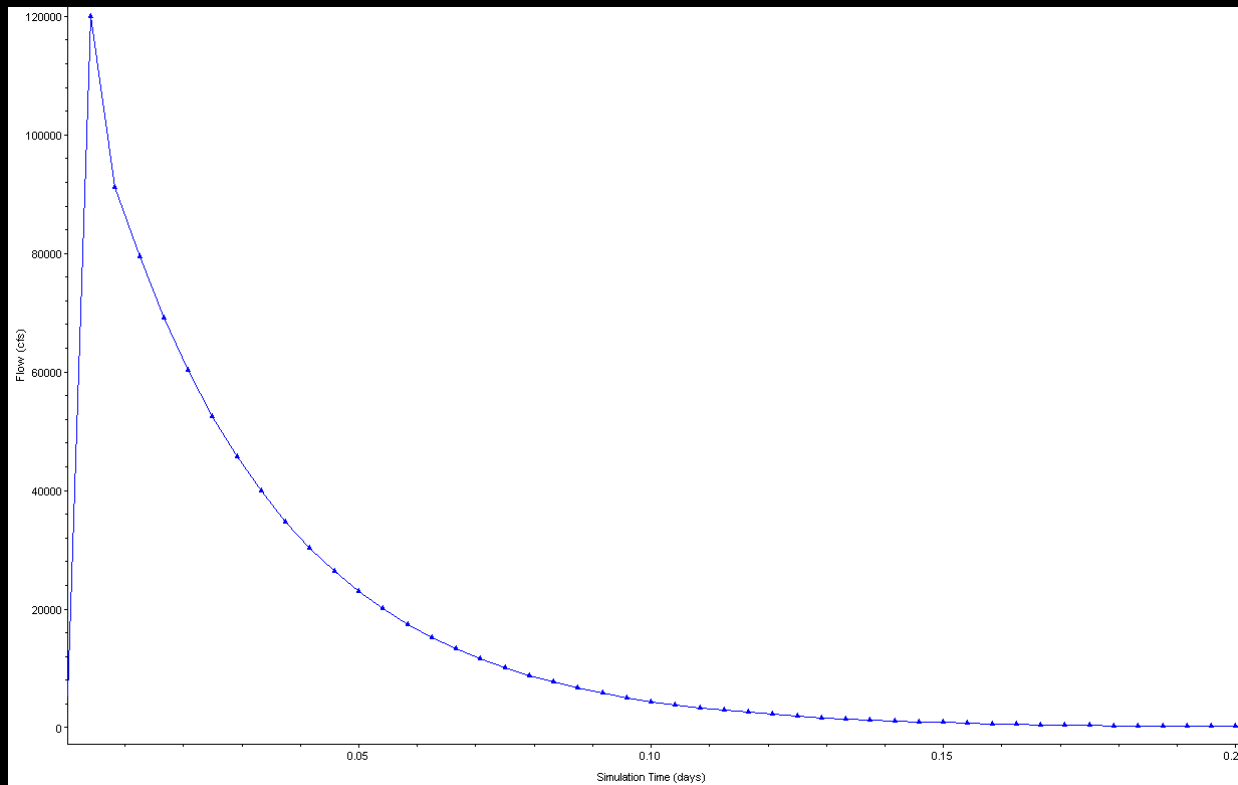- Discharge is constant over time

Technical Talk

- Discharge
- Steady state
- Unsteady state

Non-technical talk

- Flow (i.e. how much water)
- Discharge is constant over time
- Discharge changes over time

Technical Talk

- Discharge
- Steady state
- Unsteady state
- 1% annual-chance, 100-yr flood, Q100, base flood
- Roughness

- Topography
- Cross section
- Interpolation
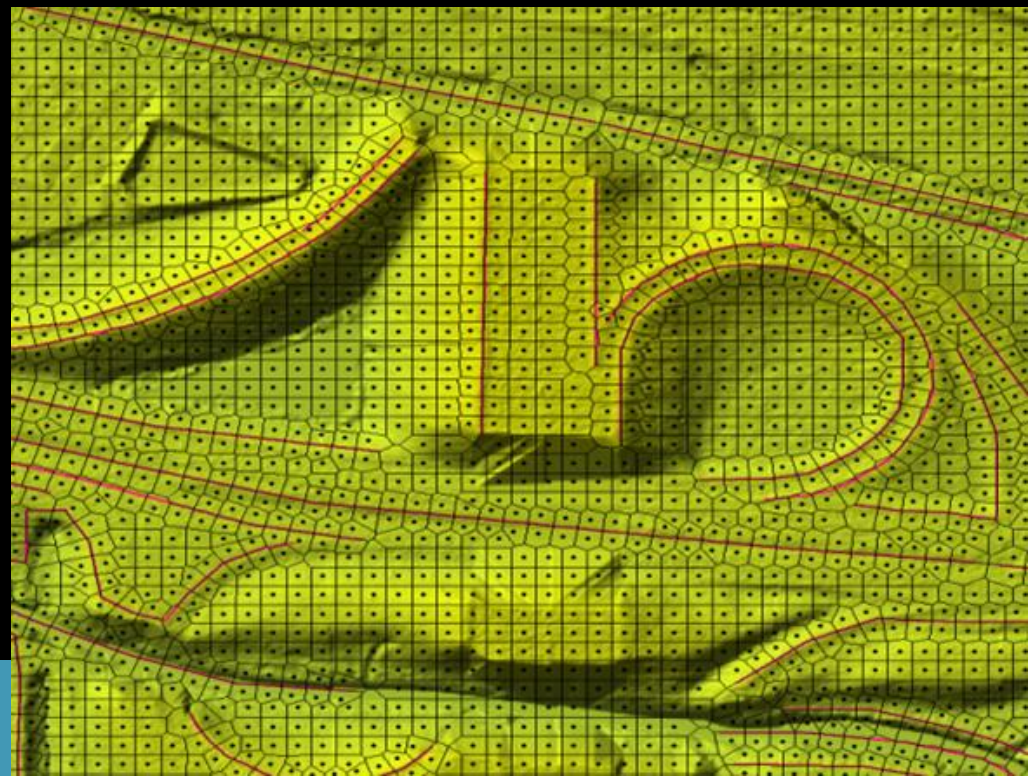- Model

Non-technical talk

- Flow (i.e. how much water)
- Discharge is constant over time
- Discharge changes over time
- 1% chance of that discharge happening within the year
- Resistance to flow based on vegetation and smoothness of the surface
- Representation of the surface
- Representation of the surface along a line
- Straight line between two points
- ????
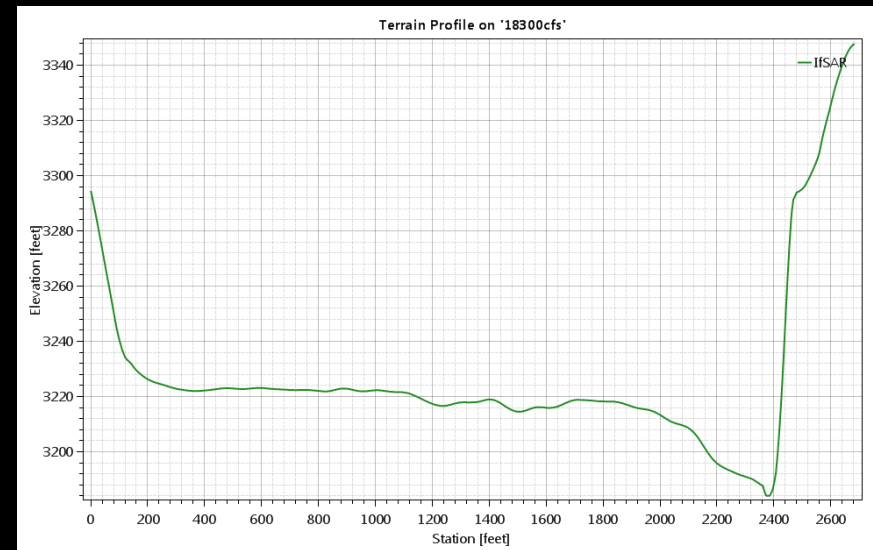
So…what is a hydraulic model?

- Set of calculations

- **Purpose**: Running numerous equations quickly
  - Similar to a group of spreadsheets talking to each other

- Allows for quick analysis

- Allows for simple comparisons of scenarios

- Most models include some form of mapping assistance
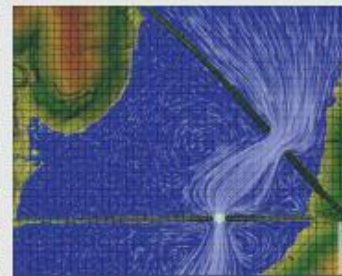
What kind of model?

Depends on what you want to know and the system.

- Single cross section
- Structure (i.e. culvert at a roadway)
- Single channel with connected floodplain
- Channel and/or floodplain splits
- System experience flood over days or it all happens within hours
- Analyzed system enclosed
- Analyzing temperature, sediment, turbulence, or habitat
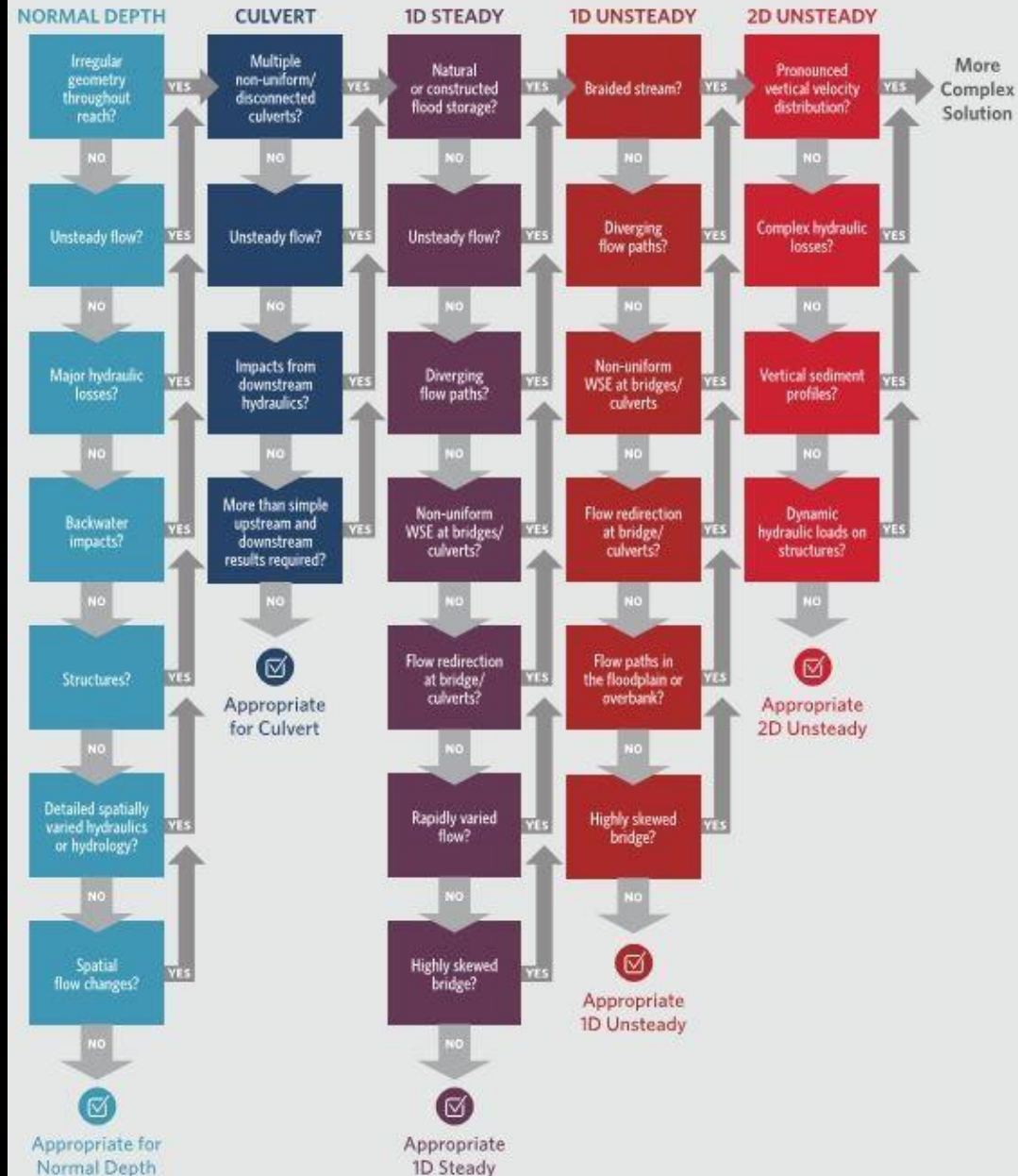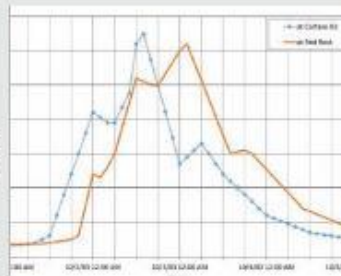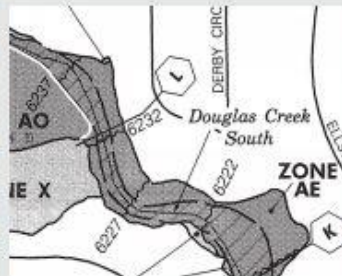
NORMAL DEPTH

» FlowMaster
» Hydraulic Toolbox

CULVERT

» HY-8
» CulvertMaster

1D STEADY

» HEC-RAS
» MIKE 11
» XPSWMM
» SWMM 5

1D UNSTEADY

» HEC-RAS
» MIKE 11
» XPSWMM
» SWMM 5
» TUFLOW

2D UNSTEADY

» HEC-RAS
» SRH-2D
» FLO-2D
» MIKE 21
» TUFLOW
» XPSWMM
» RiverFlow2D
» TrimR2D
» MIKE FLOOD
» SWMM 5

Mississippi River
Pool 13
Streamtraces

Mississippi River
Pool 13
Streamtraces

Bridge piers

Bridge piers

Velocity Magnitude (m/s)

Initial Juvenile Distribution
1 mussel per cell
35,300 individuals

Final Juvenile Distribution
1 mussel per cell
35,300 individuals

Northing (meters) (Local Coordinates)

Easting (meters)

Easting (meters) (Local Coordinates)

Slope
0.020
0.019
0.018
0.017
0.016
0.014
0.013
0.012
0.011
0.010
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000

Modeling Floodplains
Typically

- HEC-RAS
- MT is typically performed using steady state
- Based on numerous cross section locations
  - Placement decided by engineer
- Can incorporate bridges and culverts
- Solution between cross sections
- Review output and adjust

Much more than "just hit run."
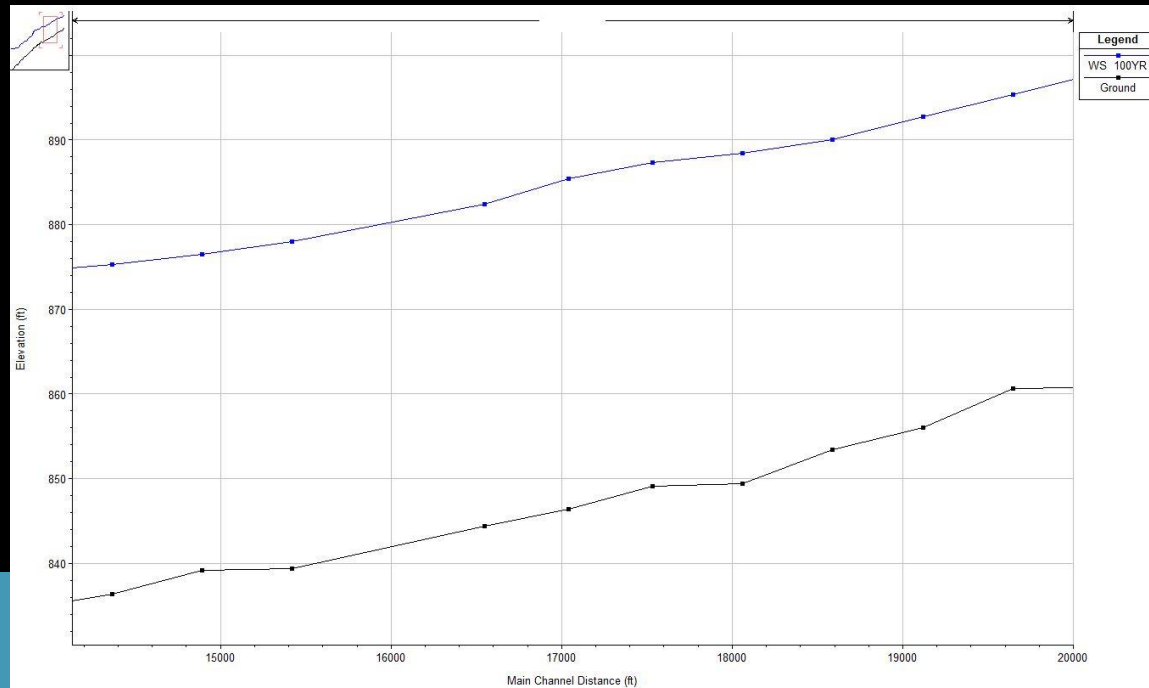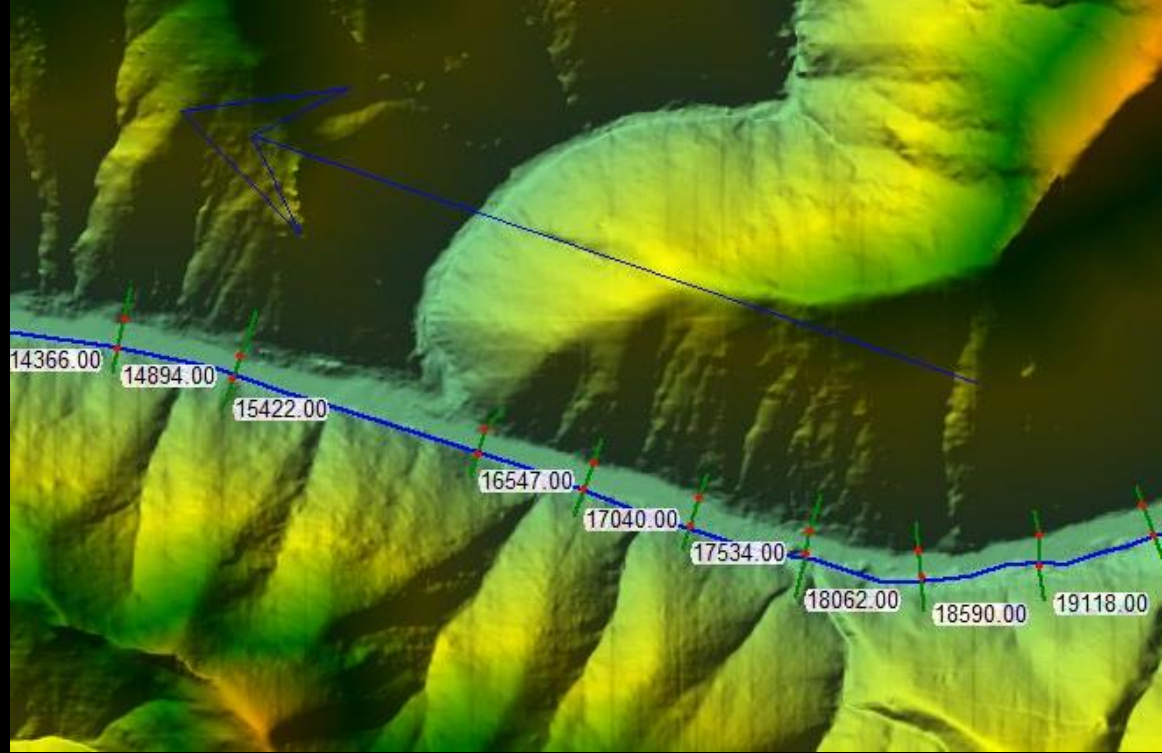
HEC-RAS Version 5.0.4 Update

- What is new
  - Beta testing 5.0.4
- What is in the plans
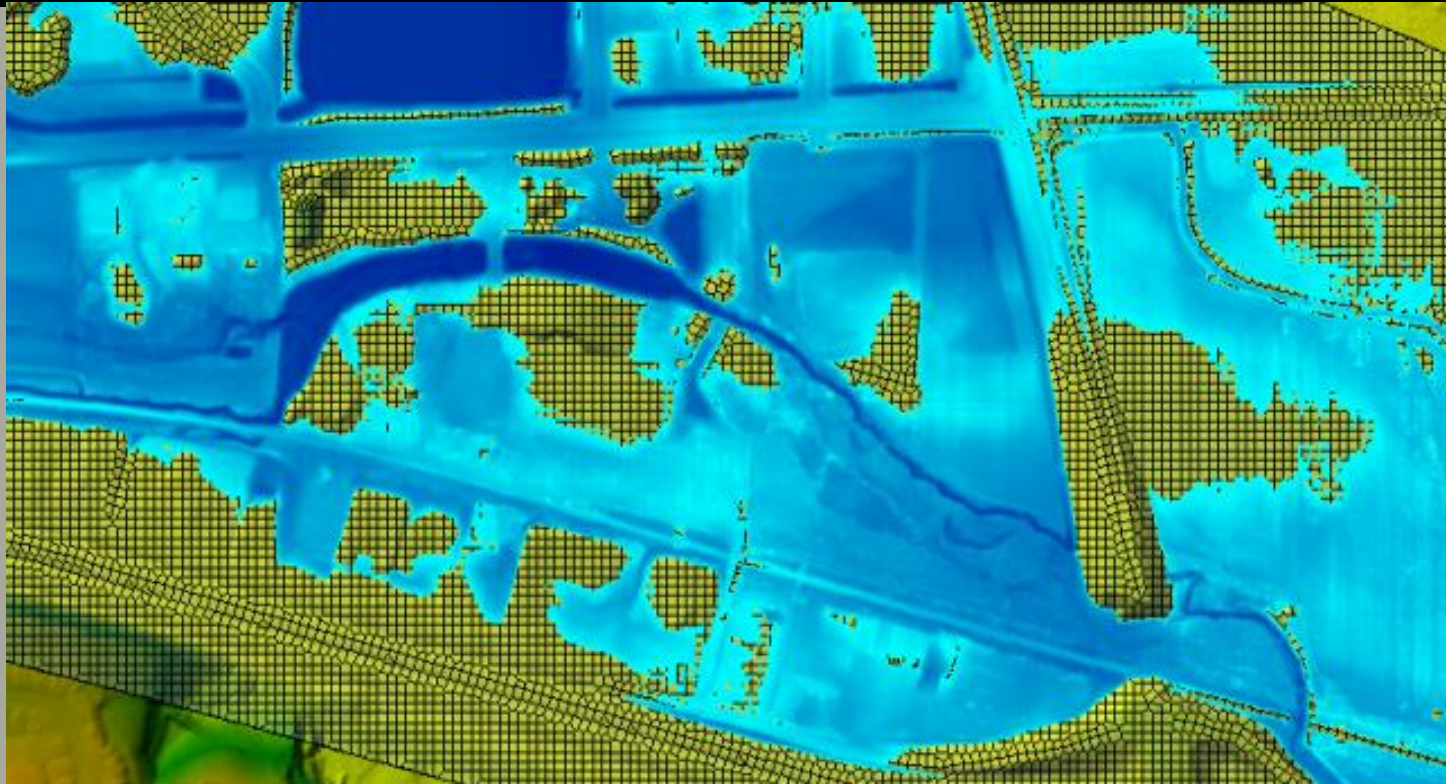
5.0.4 Modifications

▪ New RAS Mapper Pre-Processor Tools
  o Extraction of elements
    • Rivers
    • Cross sections
    • Storage Area
    • 2D elements
    • Manning's roughness layer

Graphics provided by Gary Brunner (HEC)
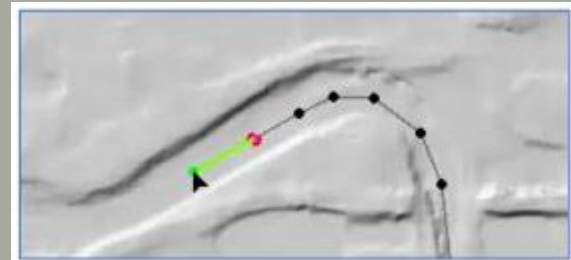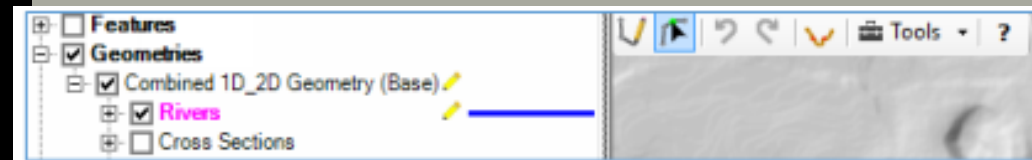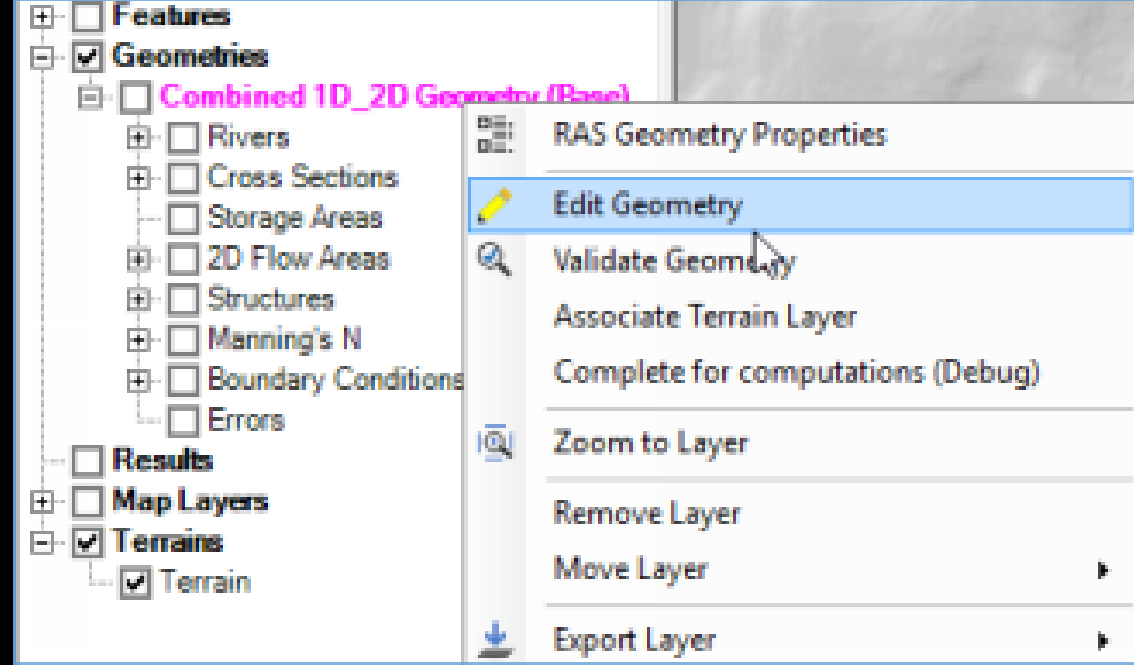
5.0.4 Modifications

- Enhancements to Storage Area / 2D Connections
  - Ability to specify the X and Y coordinates for U/A and D/S ends of each hydraulic outlet
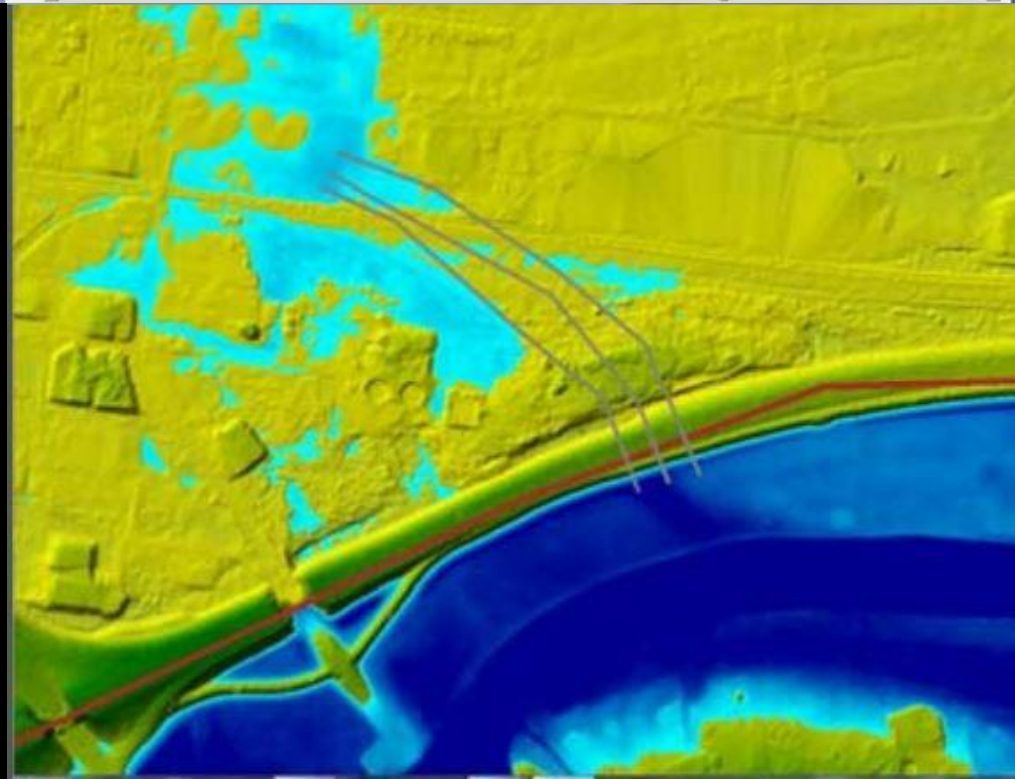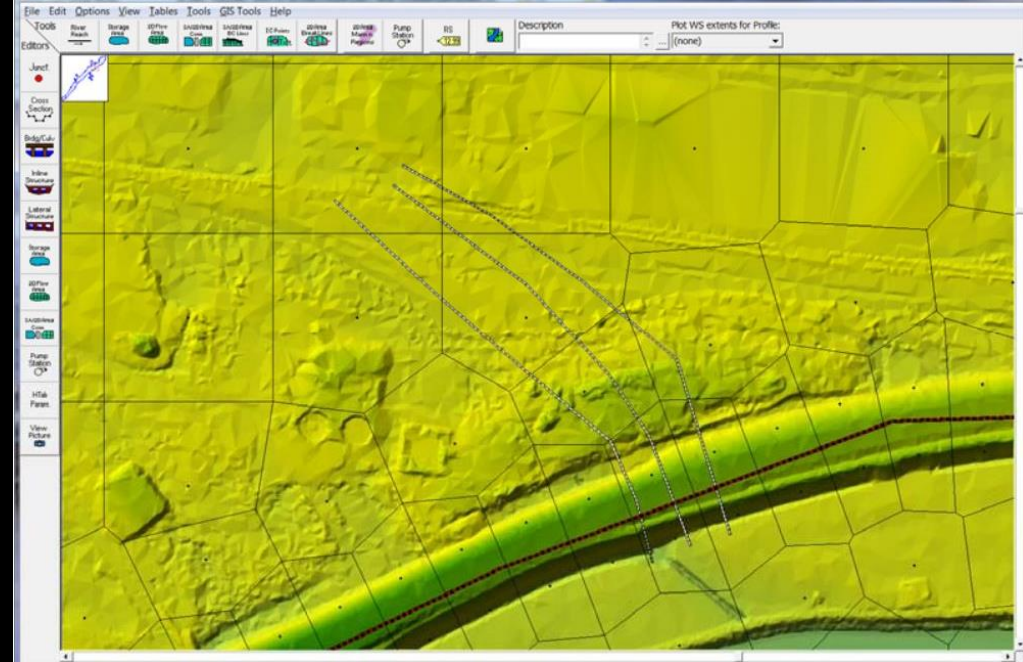
5.0.4 Modifications

- New breakline controls
- New polygon mesh refinement tool
  - Define a new grid size within a defined polygon

Graphics provided by Gary Brunner (HEC)

5.0.4 Modifications

- Variable Time Step
  - Both 1D and 2D Simulations
  - Two Methods:
    - Based on Courant Number monitoring
    - User defined table of dates and time steps

Graphics provided by Gary Brunner (HEC)

HEC-RAS Unsteady Computation Options and Tolerances

General | 2D Flow Options | 1D/2D Options | Advanced Time Step Control | 1D Mixed Flow Options

- ○ Fixed Time Step (Basic method)   [0.5 Second ▼]
- ● Adjust Time Step Based on Courant

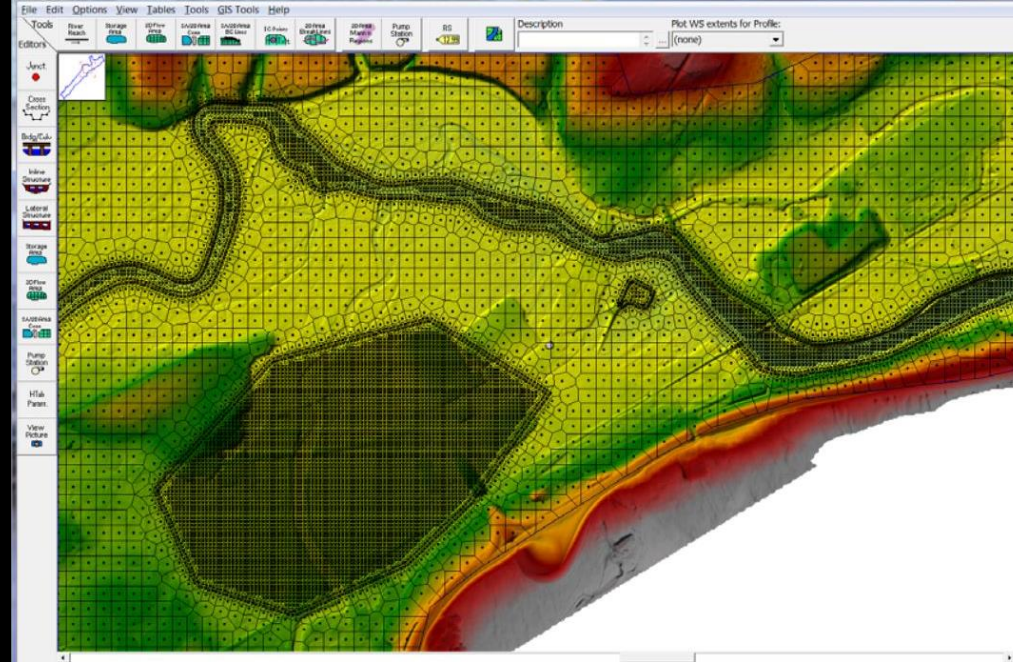|	
Maximum Courant:	1.
Minimum Courant:	0.5
Number of steps below Minimum before doubling:	10
Maximum number of doubling base time step:	1 1.00 sec
Maximum number of halving base time step:	1 0.25 sec

Courant Methodology
- ● Courant (Velocity * dt / Length)
- ○ Residence Time (flow out * dt / Volume)

- ○ Adjust Time Step Based on Time Series of Divisors   [Verify Dates ...]

	Time Step	Date(ddMMMyyyy hhmm)	Divisor
1			
2			
3			
4			
5			
6			
7			
8			

RAS Version	Timestep (s)	Error (%)	Run Time (min)
5.0.3	1	0.220	74
5.0.3	0.5	0.210	184
5.0.4	0.25 - 1	0.004	42

5.0.4 Modifications

- Internal Boundary Conditions Lines in 2D Area
  - User defines a BC line internally
  - Able to define a hydrograph
- 64-bit Version of RAS Mapper
  - Larger domains, terrain sets
  - Improved results processing
- 64-bit 2D Processor
  - Larger domain
  - Faster processing
- Computational Engine further parallelized

Graphics and table provided by Gary Brunner (HEC)
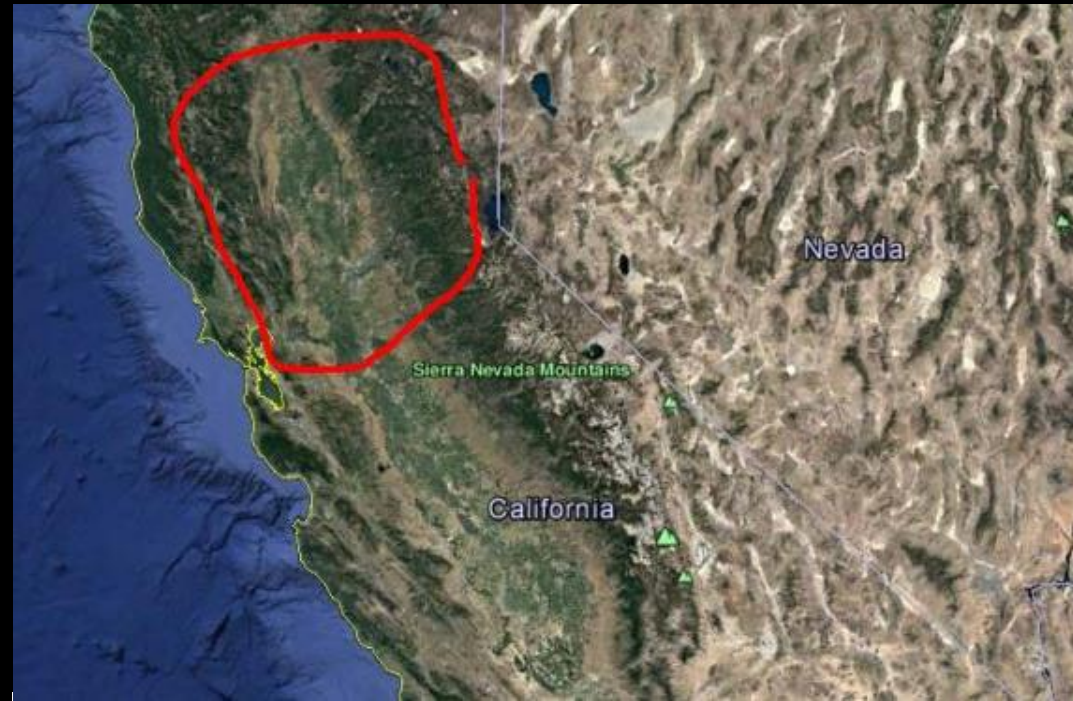
| 2D Test Name	5.0.3 Compute time	5.0.4 Compute time
EU Test No 2 10,000 cells	1min 6s	31s
EU Test No 4 80,000 cells	1 min 27s	56s
EU Test No 4 20,000 cells	27s	13s
EU Test No 5 7,460 cells	1min 40s	49s
EU Test No 5 1,809 cells	24s	13s
EU Test No 6 36,492 cells	2 min 41s	1 min 18s
EU Test No 7 16,590 cells	38 min 46s	15 min 35s
EU Test No 7 4,195 cells	15 min 47s	3 min 48s
Muncie 25ft Grids 21,724 cells	19 min 10s	8 min 52s
Cherry Cr Dambrk 55,931 cells	43 min 15s	15 min 38s
Yolo Bypass 17,141 cells	17 min 13s	9 min 15s
Boise River 10,423 cells	28 min 2s	11 min 27s
Oroville Dam Brk 133,368 cells	5 hr 46 min 29s	1 hr 57 min 24s

5.0.4 Modifications

- New Velocity Term for 2D Boundary Conditions
  - New approach estimates starting velocity
- Sediment
  - New grain class options
  - New transport functions
- Bug Fixes
  - Velocity fields
  - Less sensitive to grid sizes
  - Dry/Wet cell interfaces
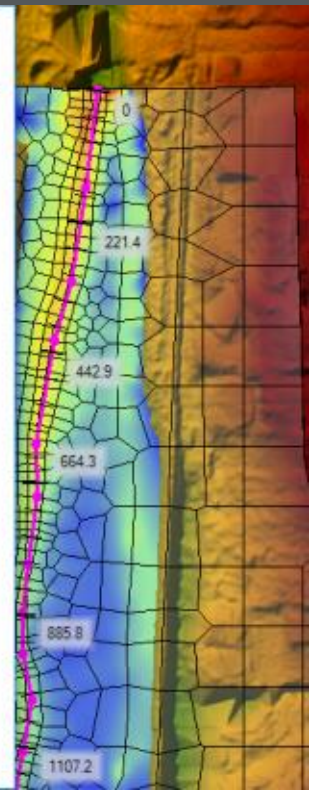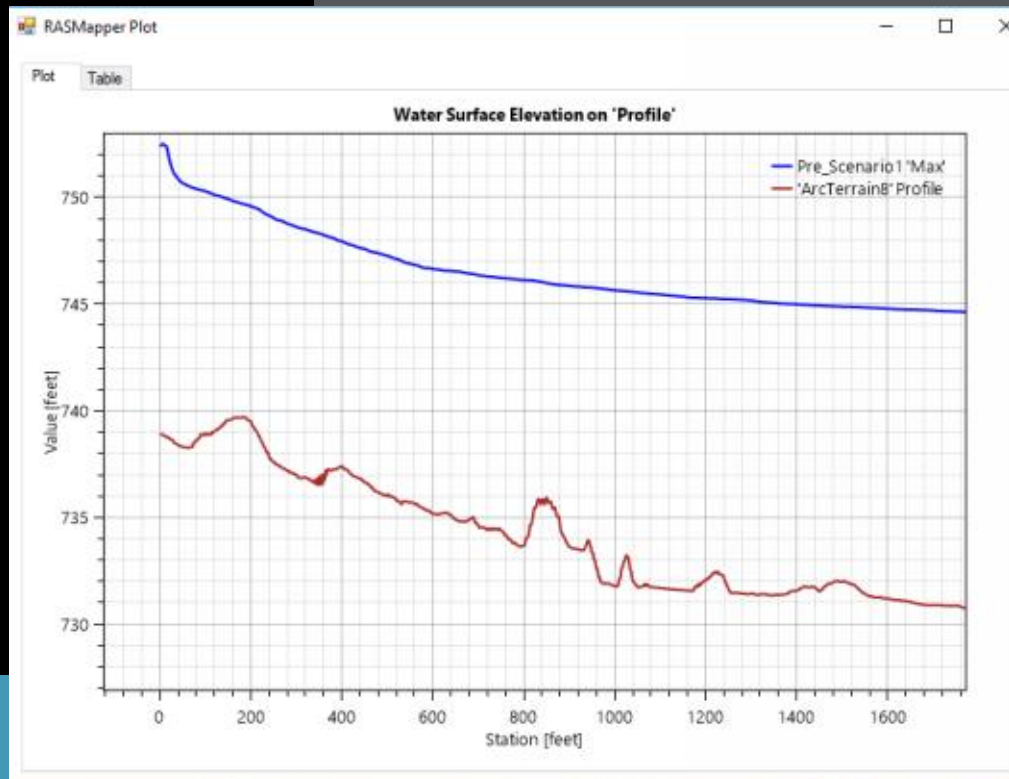
5.1 Release

- 1D Finite Volume Solver
  - More stable solution
  - Improvements in transitions between flow regimes
- Junction analysis performed as a single 2D cell
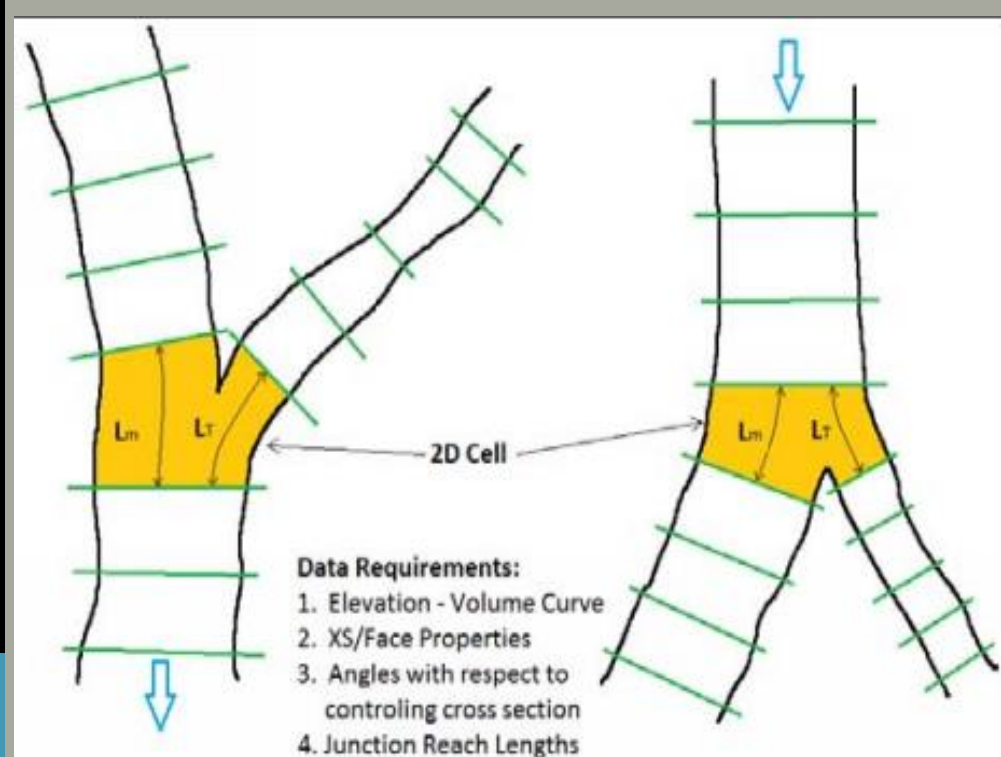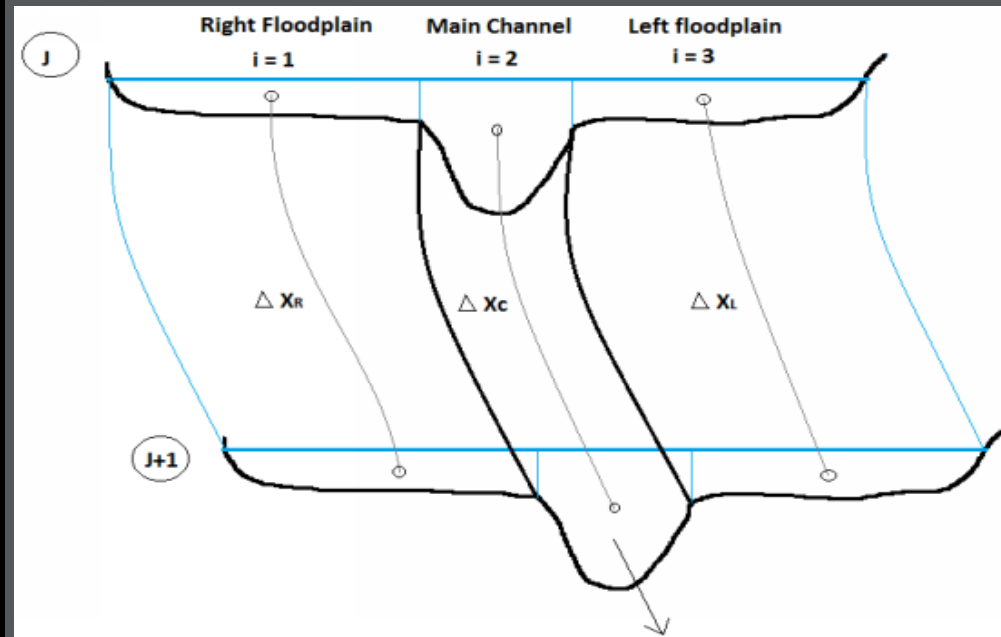
Graphics and table provided by Gary Brunner (HEC)

5.1 Release

- Enhancements to Mesh Generation Tools
- Initial Conditions for 2D Areas
  - Polygon and point values for setting initial conditions
- Pump Stations in 2D Domain
- Output for internal SA/2D Connections
- Spatially Varied Precipitation and Infiltration
- Wind Forces
- 2D Mesh Importer
  - SMS meshes: ADH, SRH and Tuflow
- Use DSS7 libraries
  - Smaller time steps
    » Currently 1 min in DSS6

Graphics and table provided by Gary Brunner (HEC)

Questions?

HDR